

(12) **United States Patent**  
**Sung et al.**

(10) **Patent No.:** **US 9,274,385 B2**  
(45) **Date of Patent:** **Mar. 1, 2016**

(54) **PIXEL STRUCTURES HAVING A SCAN LINE PASSES THROUGH THE EDGES OF A FIRST-PIXEL ROW AND THROUGH AN AREA OF A SECOND SUB-PIXEL ROW**

(71) Applicants: **Li-Wei Sung**, Chu-Nan (TW);  
**Chung-Yi Wang**, Chu-Nan (TW);  
**An-Chang Wang**, Chu-Nan (TW);  
**Yao-Lien Hsieh**, Chu-Nan (TW)

(72) Inventors: **Li-Wei Sung**, Chu-Nan (TW);  
**Chung-Yi Wang**, Chu-Nan (TW);  
**An-Chang Wang**, Chu-Nan (TW);  
**Yao-Lien Hsieh**, Chu-Nan (TW)

(73) Assignee: **INNOLUX CORPORATION** (TW)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 326 days.

(21) Appl. No.: **13/745,331**

(22) Filed: **Jan. 18, 2013**

(65) **Prior Publication Data**

US 2013/0188108 A1 Jul. 25, 2013

(30) **Foreign Application Priority Data**

Jan. 20, 2012 (TW) ..... 101102435 A

(51) **Int. Cl.**  
**G02F 1/1343** (2006.01)  
**G02F 1/1362** (2006.01)

(52) **U.S. Cl.**  
CPC .... **G02F 1/134336** (2013.01); **G02F 1/136286** (2013.01)

(58) **Field of Classification Search**  
CPC ..... G09G 2300/0426; G09G 3/3648;  
G09G 2300/0443; G09G 3/3659; G09G  
2300/0439; G09G 2300/0452; G09G  
2310/0281; G09G 3/3614; G09G 3/3655;  
G09G 3/3611

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

5,563,727 A *	10/1996	Larson et al.	349/143
5,757,444 A *	5/1998	Takemura	349/38
7,397,455 B2 *	7/2008	Elliott et al.	345/88
8,023,089 B2 *	9/2011	Yeh	349/145
8,035,596 B2 *	10/2011	Sekine	G09G 3/3659 345/90
8,179,350 B2 *	5/2012	Park	G02F 1/1368 345/87
2005/0041188 A1	2/2005	Yamazaki	
2005/0099378 A1 *	5/2005	Kim	345/99
2006/0050210 A1	3/2006	Tsuchiya	
2007/0070093 A1 *	3/2007	Lin et al.	345/694

**FOREIGN PATENT DOCUMENTS**

CN	101976007	2/2011
JP	H04140725	5/1992
JP	05-297405	11/1993
JP	H06186575	7/1994
JP	H08240812	9/1996
TW	200730923	8/2007
WO	96/00926 A2	1/1996
WO	WO 2010/113435	10/2010

**OTHER PUBLICATIONS**

Office Action dated Aug. 20, 2014 from corresponding No. TW 101102435.

Office Action dated Feb. 12, 2014 from corresponding application No. JP 2013-007036.

European Search Report for Application No./Patent No. 13151481. 2-1904, Apr. 26, 2013.

\* cited by examiner

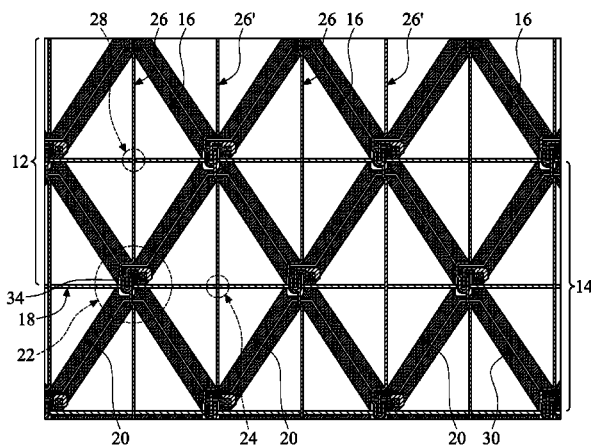
*Primary Examiner* — Huyen Ngo

(74) *Attorney, Agent, or Firm* — Hauptman Ham, LLP

(57) **ABSTRACT**

In an embodiment of the disclosure, a pixel structure is provided. The pixel structure includes a first sub-pixel row including a plurality of sub-pixels electrically connecting to a first scan line, and a second sub-pixel row including a plurality of sub-pixels, wherein the first scan line passes through an area of the sub-pixels of the second sub-pixel row.

**17 Claims, 5 Drawing Sheets**



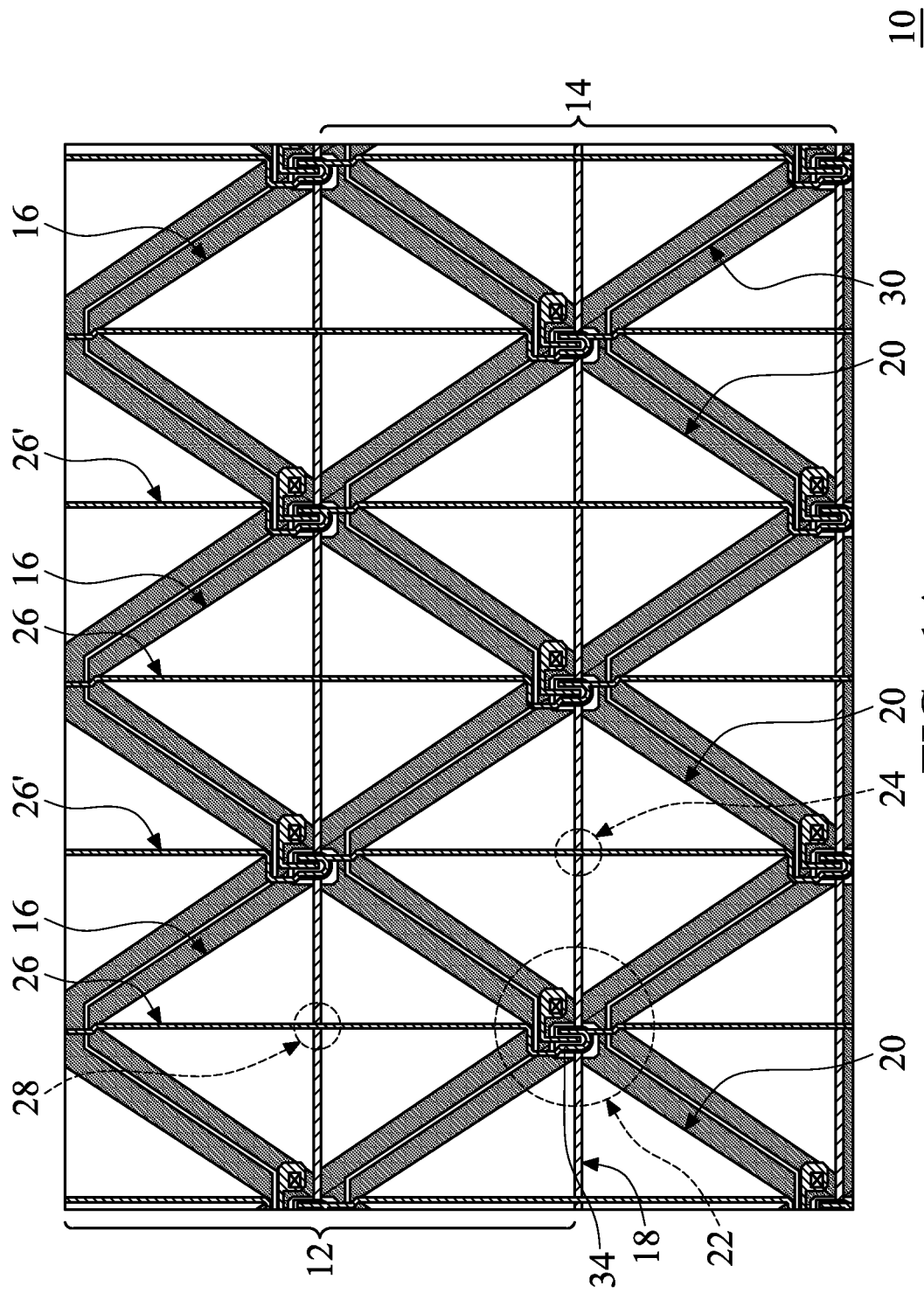
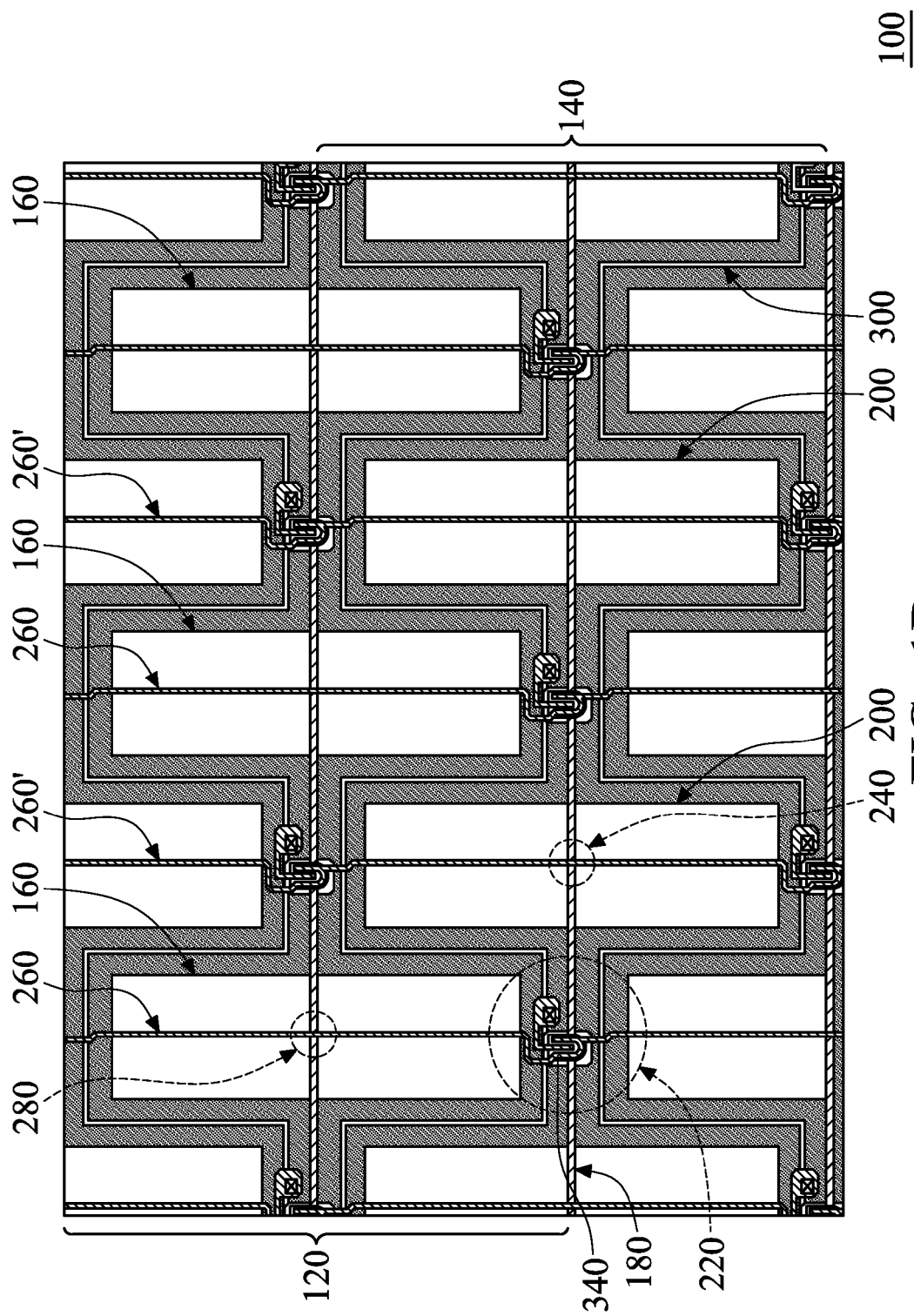


FIG. 1A



**FIG. 1B**

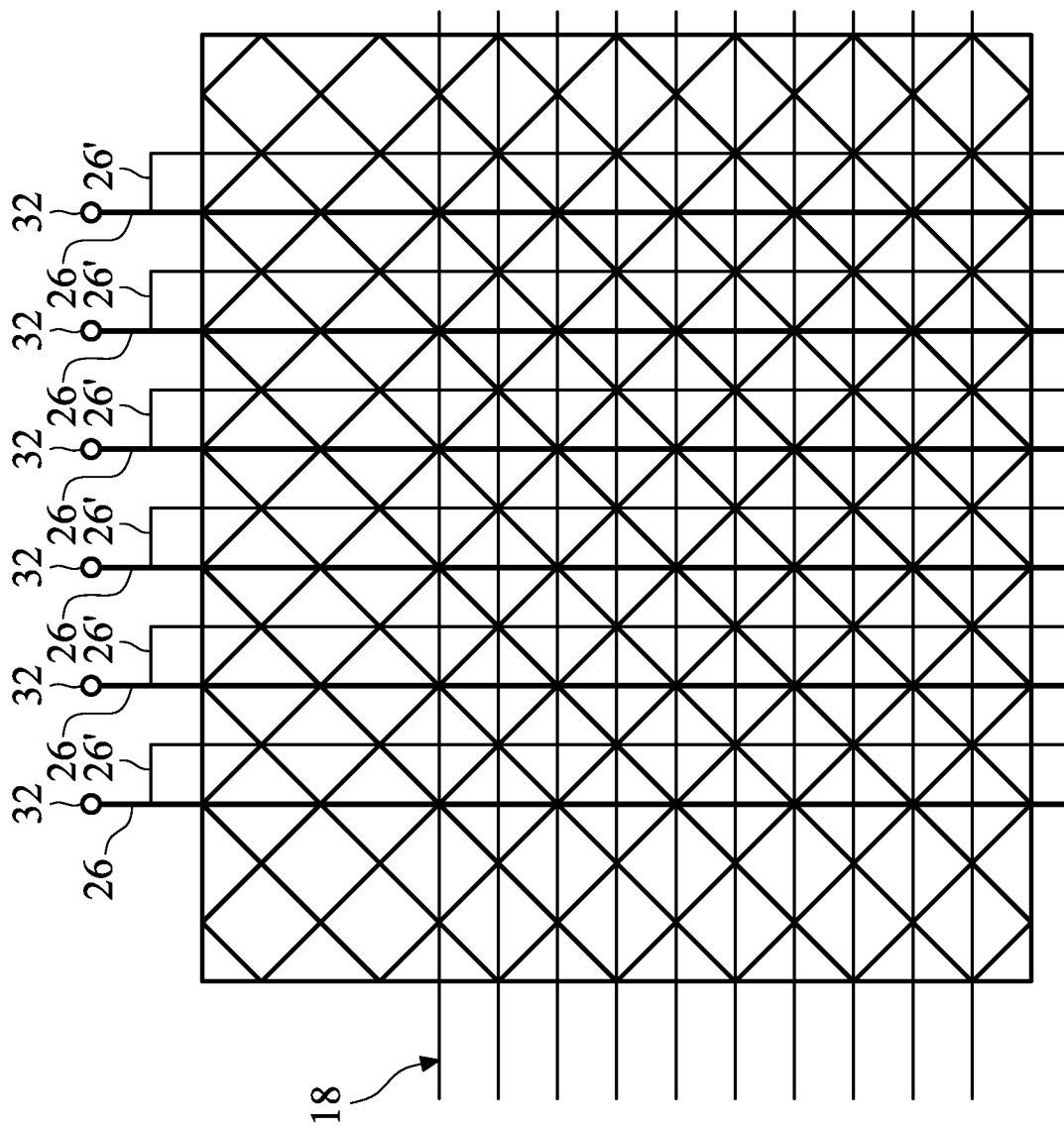
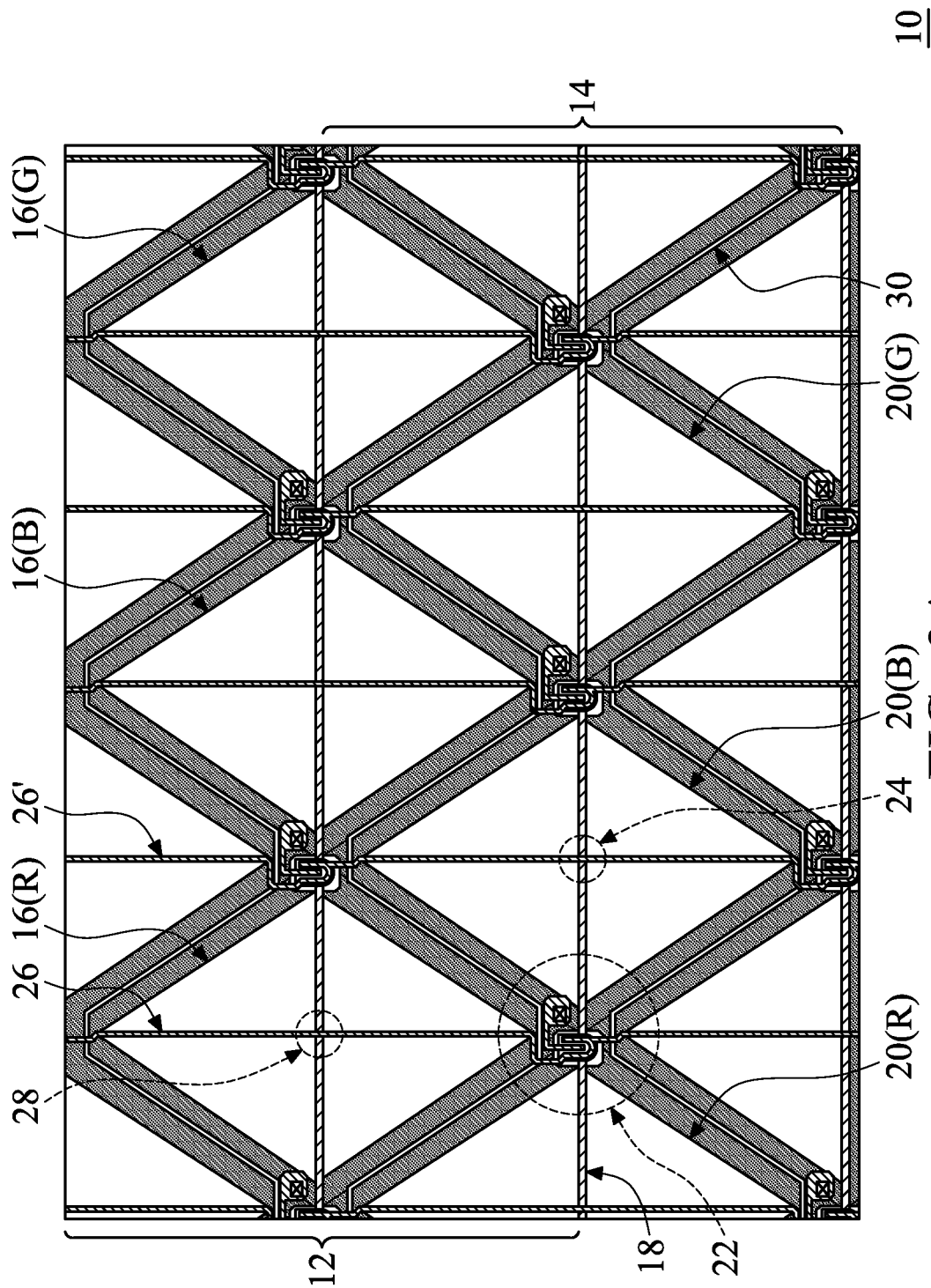


FIG. 2



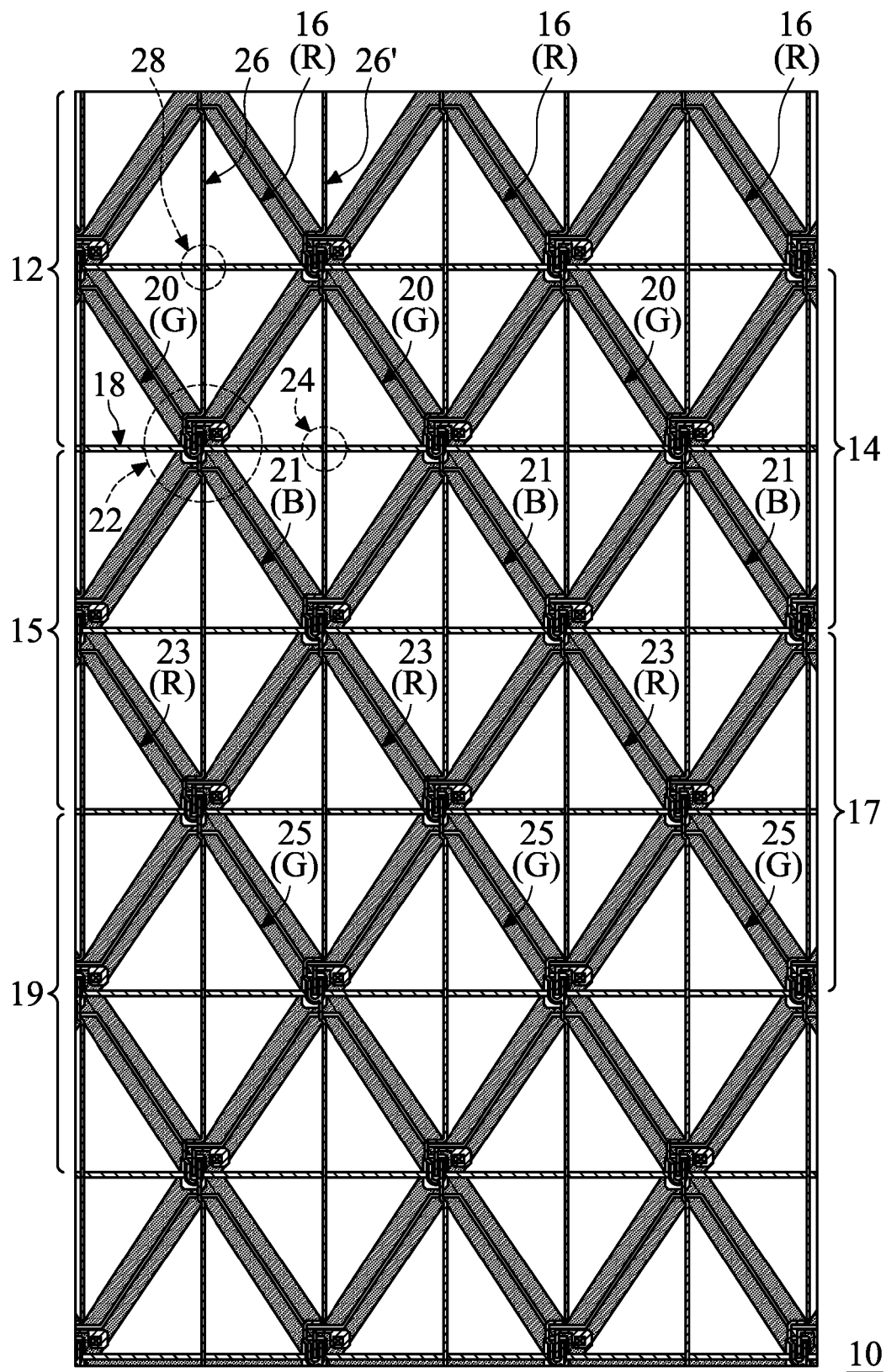


FIG. 3B

1

# PIXEL STRUCTURES HAVING A SCAN LINE PASSES THROUGH THE EDGES OF A FIRST-PIXEL ROW AND THROUGH AN AREA OF A SECOND SUB-PIXEL ROW

## CROSS REFERENCE TO RELATED APPLICATIONS

This Application claims priority of Taiwan Patent Application No. 101102435, filed on Jan. 20, 2012, the entirety of which is incorporated by reference herein.

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The disclosure relates to a pixel structure, and in particular to a pixel structure with high light penetration, capable of efficiently controlling feedthrough.

### 2. Description of the Related Art

For vertical alignment (VA) wide viewing angle technology, if the efficiency of liquid crystals located at a boundary between two areas with different liquid crystal orientations is unsatisfactory, light penetration of the panels will be poor. Also, when being fabricated, opaque metal lines also cause light penetration of the panels to be poor. Generally speaking, a pixel electrode design can optimize light penetration. For instance, designers try to narrow the area with low liquid crystal efficiency. However, some optical problems come up. For example, excessive capacitive coupling effects which cause crosstalk, or an asymmetrical positive/negative half-cycle voltage which results in fabrication difficulty and decreased yield and product reliability, etc.

“Feedthrough” is a capacitive coupling effect which is produced when a transistor is turned on and then turned off. Voltage is from high to low (taking CMI Corp. for example), therefore, the coupling direction is to pull the pixel electrode voltage downward. Liquid crystals will be driven in a positive/negative half-cycle AC status in order to prevent the liquid crystals from polarization which loses the original characteristics thereof. At this time, if the “feedthrough” is excessively heavy, the symmetry of positive/negative half-cycle will be decreased, resulting in fabrication and optical problems.

## BRIEF SUMMARY OF THE INVENTION

One embodiment of the disclosure provides a pixel structure, comprising: a first sub-pixel row comprising a plurality of sub-pixels electrically connecting to a first scan line; and a second sub-pixel row comprising a plurality of sub-pixels, wherein the first scan line passes through an area of the sub-pixels of the second sub-pixel row.

The sub-pixels of the first sub-pixel row and the second sub-pixel row are in a shape of a rectangle, rhombus or polygon.

The sub-pixels of the first sub-pixel row comprise one of red, blue or green pixels or a combination thereof.

The sub-pixels of the second sub-pixel row comprise one of red, blue or green pixels or a combination thereof.

The area of the sub-pixels of the second sub-pixel row where the first scan line passes through, corresponds to a liquid crystal shadow area.

The sub-pixels of the second sub-pixel row are respectively disposed between the sub-pixels of the first sub-pixel row such that the sub-pixels of the first sub-pixel row and the sub-pixels of the second sub-pixel row are in a staggered arrangement.

2

The pixel structure further comprises a plurality of first data lines passing through an area of the sub-pixels of the first sub-pixel row.

The area of the sub-pixels of the first sub-pixel row where the first data lines pass through, corresponds to a liquid crystal shadow area.

The pixel structure further comprises a plurality of second data lines passing through an area of the sub-pixels of the second sub-pixel row.

The area of the sub-pixels of the second sub-pixel row where the second data lines pass through, corresponds to a liquid crystal shadow area.

The pixel structure further comprises a plurality of common electrodes disposed on the edges of the sub-pixels of the first sub-pixel row and the second sub-pixel row.

The common electrodes are zigzag or concavo-convex.

The first scan line passes through the edges of the sub-pixels of the first sub-pixel row and is vertical to the first data lines.

The first scan line passes through the center of the sub-pixels of the second sub-pixel row.

The pixel structure further comprises a plurality of driving devices, wherein each of the driving devices simultaneously controls one first data line and one second data line.

The pixel structure further comprises a plurality of driving transistors, wherein the driving transistors are electrically connected to the sub-pixels of the first sub-pixel row and disposed between the two adjacent sub-pixels of the second sub-pixel row.

One embodiment of the disclosure provides an electronic device incorporating a display panel, the display panel comprising: a first sub-pixel row comprising a plurality of sub-pixels electrically connecting to a first scan line; and a second sub-pixel row comprising a plurality of sub-pixels, wherein the first scan line passes through an area of the sub-pixels of the second sub-pixel row.

A detailed description is given in the following embodiments with reference to the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawing, wherein:

FIG. 1A shows a top view of a pixel structure according to an embodiment of the disclosure;

FIG. 1B shows a top view of a pixel structure according to an embodiment of the disclosure;

FIG. 2 shows a top view of a pixel structure according to an embodiment of the disclosure;

FIG. 3A shows a top view of a pixel structure according to an embodiment of the disclosure; and

FIG. 3B shows a top view of a pixel structure according to an embodiment of the disclosure.

## DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1A, in accordance with one embodiment of the disclosure, a pixel structure is provided. A pixel structure 10 comprises a first sub-pixel row 12 and a second sub-pixel row 14. The first sub-pixel row 12 comprises a plurality of sub-pixels 16 electrically connecting to a first scan line 18. The second sub-pixel row 14 comprises a plurality of sub-pixels 20. Specifically, the first scan line 18 passes through an area of the sub-pixels 20 of the second

sub-pixel row **14**, for example the first scan line **18** passes through a center **24** of the sub-pixels **20** of the second sub-pixel row **14**.

In this embodiment, the sub-pixels (**16**, **20**) of the first sub-pixel row **12** and the second sub-pixel row **14** are in a shape of a rhombus, but the disclosure is not limited thereto. In other embodiments, the sub-pixels (**16**, **20**) of the first sub-pixel row **12** and the second sub-pixel row **14** may be in a shape of a rectangle or polygon. Referring to FIG. 1B, in accordance with another embodiment of the disclosure, a pixel structure is provided. A pixel structure **100** comprises a first sub-pixel row **120** and a second sub-pixel row **140**. The first sub-pixel row **120** comprises a plurality of sub-pixels **160** electrically connected to a first scan line **180**. The second sub-pixel row **140** comprises a plurality of sub-pixels **200**. Specifically, the first scan line **180** passes through an area of the sub-pixels **200** of the second sub-pixel row **140**, for example the first scan line **180** passes through a center **240** of the sub-pixels **200** of the second sub-pixel row **140**.

In this embodiment, the sub-pixels (**160**, **200**) of the first sub-pixel row **120** and the second sub-pixel row **140** are in a shape of a rectangle.

Next, referring to FIGS. 3A and 3B, the sub-pixels **16** of the first sub-pixel row **12** may comprise a combination of red, blue and green sub-pixels, for example a red sub-pixel R, a blue sub-pixel B and a green sub-pixel G are horizontally arranged, as shown in FIG. 3A. Similarly, the sub-pixels **20** of the second sub-pixel row **14** may also comprise a combination of red, blue and green sub-pixels, for example a red sub-pixel R, a blue sub-pixel B and a green sub-pixel G are horizontally arranged, as shown in FIG. 3A. Additionally, referring to FIG. 3B, the sub-pixels **16** of the first sub-pixel row **12** may also comprise one of red, blue or green sub-pixels, for example red sub-pixels R. The sub-pixels **20** of the second sub-pixel row **14** may also comprise one of red, blue or green sub-pixels, for example green sub-pixels G. Sub-pixels **21** of a third sub-pixel row **15** may also comprise one of red, blue or green sub-pixels, for example blue sub-pixels B. Sub-pixels **23** of a fourth sub-pixel row **17** may comprise one of red, blue or green sub-pixels, for example red sub-pixels R. Sub-pixels **25** of a fifth sub-pixel row **19** may comprise one of red, blue or green sub-pixels, for example green sub-pixels G such that, for example the red sub-pixel **16** (R), the blue sub-pixel **21** (B) and the green sub-pixel **25** (G) are vertically arranged.

Specifically, the area of the sub-pixels **20** of the second sub-pixel row **14** where the first scan line **18** passes through, corresponds to a liquid crystal shadow area. The liquid crystal shadow area is formed by an improper arrangement of liquid crystals located at a boundary between two areas with different liquid crystal orientations under an electric field. Additionally, as shown in FIG. 1A, the sub-pixels **20** of the second sub-pixel row **14** are respectively disposed between the sub-pixels **16** of the first sub-pixel row **12** such that the sub-pixels **16** of the first sub-pixel row **12** and the sub-pixels **20** of the second sub-pixel row **14** are in a staggered arrangement.

Additionally, still referring to FIG. 1A, the pixel structure **10** further comprises a plurality of first data lines **26** passing through an area corresponding to a liquid crystal shadow area of the sub-pixels **16** of the first sub-pixel row **12**, for example the first data line **26** passes through a center **28** of the sub-pixels **16** of the first sub-pixel row **12**. The pixel structure **10** further comprises a plurality of second data lines **26'** passing through an area corresponding to a liquid crystal shadow area of the sub-pixels **20** of the second sub-pixel row **14**, for example the second data line **26'** passes through the center **24** of the sub-pixels **20** of the second sub-pixel row **14**.

Specifically, the first scan line **18** passes through edges **22** of the sub-pixels **16** of the first sub-pixel row **12** and is vertical to the first data lines **26**.

The pixel structure **10** further comprises a plurality of common electrodes **30** disposed on the edges of the sub-pixels (**16**, **20**) of the first sub-pixel row **12** and the second sub-pixel row **14**, for example the common electrodes **30** are zigzag, as shown in FIG. 1A.

The pixel structure **10** further comprises a plurality of driving transistors **34** electrically connected to the sub-pixels **16** of the first sub-pixel row **12** and disposed between the two adjacent sub-pixels (**20**, **20**) of the second sub-pixel row **14**.

In another embodiment, referring to FIG. 1B, the pixel structure **100** further comprises a plurality of first data lines **260** passing through an area corresponding to a liquid crystal shadow area of the sub-pixels **160** of the first sub-pixel row **120**, for example the first data line **260** passes through a center **280** of the sub-pixels **160** of the first sub-pixel row **120**. The pixel structure **100** further comprises a plurality of second data lines **260'** passing through an area corresponding to a liquid crystal shadow area of the sub-pixels **200** of the second sub-pixel row **140**, for example the second data line **260'** passes through the center **240** of the sub-pixels **200** of the second sub-pixel row **140**.

Specifically, the first scan line **180** passes through edges **220** of the sub-pixels **160** of the first sub-pixel row **120** and is vertical to the first data lines **260**.

The pixel structure **100** further comprises a plurality of common electrodes **300** disposed on the edges of the sub-pixels (**160**, **200**) of the first sub-pixel row **120** and the second sub-pixel row **140**, for example the common electrodes **300** are concavo-convex, as shown in FIG. 1B.

The pixel structure **100** further comprises a plurality of driving transistors **340** electrically connected to the sub-pixels **160** of the first sub-pixel row **120** and disposed between the two adjacent sub-pixels (**200**, **200**) of the second sub-pixel row **140**.

Additionally, referring to FIG. 2, the pixel structure **10** further comprises a plurality of driving devices **32**. Specifically, each of the driving devices **32** simultaneously controls one first data line **26** and one second data line **26'**.

In the disclosure, for example a scan line of a first sub-pixel row is buried in an area corresponding to a liquid crystal shadow area of a second sub-pixel row due to a staggered arrangement of adjacent sub-pixels (sub-pixels of different rows). That is, opaque metal lines (for example a scan line and a data line) are combined with the liquid crystal shadow area with low liquid crystal efficiency, maximizing light penetration. Simultaneously, low capacitive coupling effect (feedthrough) remains due to the pixel electrode (ITO) of the second sub-pixel row across the scan line of the first sub-pixel row, significantly reducing conventional side effects produced from light penetration maximization.

While the disclosure has been described by way of example and in terms of preferred embodiment, it is to be understood that the disclosure is not limited thereto. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A display panel, comprising:

- a first sub-pixel row comprising a plurality of sub-pixels electrically connecting to a scan line; and
- a second sub-pixel row comprising a plurality of sub-pixels, wherein the scan line passes through an area of the



5

sub-pixels of the second sub-pixel row, and the scan line passes through the edges of the sub-pixels of the first sub-pixel row.

2. The display panel as claimed in claim 1, wherein the sub-pixels of the first sub-pixel row and the second sub-pixel row are in a shape of a rectangle, rhombus or polygon.

3. The display panel as claimed in claim 1, wherein the sub-pixels of the first sub-pixel row comprise one of red, blue or green sub-pixels or a combination thereof.

4. The display panel as claimed in claim 1, wherein the sub-pixels of the second sub-pixel row comprise one of red, blue or green sub-pixels or a combination thereof.

5. The display panel as claimed in claim 1, wherein the area of the sub-pixels of the second sub-pixel row where the scan line passes through, corresponds to a liquid crystal shadow area.

6. The display panel as claimed in claim 1, wherein the sub-pixels of the second sub-pixel row are respectively disposed between the sub-pixels of the first sub-pixel row such that the sub-pixels of the first sub-pixel row and the sub-pixels of the second sub-pixel row are in a staggered arrangement.

7. The display panel as claimed in claim 1, further comprising a plurality of first data lines passing through an area of the sub-pixels of the first sub-pixel row.

8. The display panel as claimed in claim 7, wherein the area of the sub-pixels of the first sub-pixel row where the first data lines pass through, corresponds to a liquid crystal shadow area.

9. The display panel as claimed in claim 7, further comprising a plurality of second data lines passing through an area of the sub-pixels of the second sub-pixel row.

6

10. The display panel as claimed in claim 9, wherein the area of the sub-pixels of the second sub-pixel row where the second data lines pass through, corresponds to a liquid crystal shadow area.

11. The display panel as claimed in claim 9, further comprising a plurality of driving devices, wherein each of the driving devices simultaneously controls one first data line and one second data line.

12. The display panel as claimed in claim 7, wherein the scan line is vertical to the first data lines.

13. The display panel as claimed in claim 1, further comprising a plurality of common electrodes disposed on the edges of the sub-pixels of the first sub-pixel row and the second sub-pixel row.

14. The display panel as claimed in claim 13, wherein the common electrodes are zigzag or concavo-convex.

15. The display panel as claimed in claim 1, wherein the scan line passes through the center of the sub-pixels of the second sub-pixel row.

16. The display panel as claimed in claim 1, further comprising a plurality of driving transistors, wherein the driving transistors are electrically connected to the sub-pixels of the first sub-pixel row and disposed between the two adjacent sub-pixels of the second sub-pixel row.

17. An electronic device incorporating a display panel, the display panel comprising:

a first sub-pixel row comprising a plurality of sub-pixels electrically connecting to a scan line; and

a second sub-pixel row comprising a plurality of sub-pixels, wherein the scan line passes through an area of the sub-pixels of the second sub-pixel row, and the scan line passes through the edges of the sub-pixels of the first sub-pixel row.

\* \* \* \* \*